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Original Article

MICRONUTRIENT – INTERACTION AMONG SCHOOL CHILDREN

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ABSTRACT

Multiple-micronutrient deficiencies are most common and widespread among the vulnerable groups, especially in the children, in many developing countries, including India. The present study aims to assessing the effect of supplementation of combination of micronutrients in the reduction of the micronutrient deficiencies. The study was conducted on 450 children in the age group of 8-10 years from upper primary municipal schools located in the Tirupati urban areas. Among them 120 children, who were stunted and stunted and wasted having micronutrient deficiency were chosen for the study. They were further divided into 10 groups each to receive Fe+Vit-C, Zn+Fe, Vit-A+Zn, Vit-A+Fe& placebo. **The intervention was done over a four month period.** ***The supplementation impact was assessed through anthropometric measurements and biochemical parameters. The findings of the study supports the combination of nutrient supplementation as evidenced by significant improvement in the parameters of growth status. And some combinations showed improvement in biochemical status. In conclusion, the study strongly favours combination of nutrients supplement approach will serve as an effective method to combat micronutrient malnutrition. So it exists the positive interaction between the nutrients (micronutrients).***

***KEYWORDS:** Micronutrient Deficiency, School Children, Stunted, Stunted & Wasted and Anthropometry*

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INTRODUCTION

Micronutrient deficiency or dietary deficiency is a lack of one or more of the micronutrients required for plant or animal health. In humans and other animals they include both vitamin deficiencies and mineral deficiencies (Young, 2012). Micronutrient deficiencies affect more than two billion people of all ages in both developing and industrialized countries. They are the cause of some diseases, exacerbate others and are recognized as having an important impact on worldwide health. Important micronutrients include iodine, iron, zinc, calcium, selenium, fluorine, and vitamins A, B_6, B_{12}, B_1, B_2, B_3, and C. (Tulchinsky, 2010).

Recent estimates indicate that globally over two billion people are at risk for vitamin A, iodine, and/or iron deficiency, in spite of recent efforts in the prevention and control of these deficiencies. The prevalence is especially high in pregnant women and young children are at greatest risk. Other micronutrient deficiencies of public health concern include zinc, folate, and the B vitamins. (Usha, 2002).

Micronutrient malnutrition is a growing concern in the developing world, resulting in diverse health and social problems, such as mental retardations, impairments of the immune system and overall poor health. In recent years, the zinc (Zn) deficiency problem has received increasing attention and appears to be the most serious micronutrient deficiency together with vitamin A deficiency. Zinc deficiency is particularly widespread among children and represents a major cause of child death in the world. In countries where Zn deficiency is well documented as an important public health problem (Ismail Cakmak, 2009).

The past few decades have been called the “micronutrient era,” during which many studies have examined the benefits of providing micronutrients to improve maternal and child health outcomes (Jonsson, 2010). Many of these studies examined single nutrients such as vitamin A, zinc, or iron with varying outcomes and results.

FAO (2004) in its report on the state of food insecurity in the world pointed out that six of the ten leading risk factors for DALY (Disability Adjusted Life Years) in some of the developing countries with high mortality are related to hunger and malnutrition, including underweight. The deficiency in iron occupies the sixth, while zinc is ranked fifth and vit-A seventh.

In this context multi micronutrient deficiencies prevalent among the children in the school age group specific interventions addressing this age group are necessary (Sireesha and Kusuma, 2015).In this background the present investigation was carried out with the aim of to study the micronutrient malnutrition and interaction between the micronutrients in the school going children.

METHODOLOGY

Selection of the Subjects: The children in the age group of 8-10 years from nine municipal upper primary schools in the Tirupati urban area were selected for the study. Available 450 children nutritional status were assessed using selected anthropometric and biochemical parameters. Based on the anthropometry all the children were categorized into different nutritional grades using Water low’s classification as normal (N), wasted (W), stunted (S) and stunted and wasted (SW).From the 450 children 120 were randomly chosen from the different nutritional grades viz., stunted (S=60) and stunted & wasted (SW=60) and were initiated into the different supplementation protocols and placebo groups. There was only one child in the wasted group and hence it was not included for the study.

Conduct of Supplementation Study: The supplementations were given based on the advice of a pediatrician. The nutrient composition of the supplements is presented in table 1.

Table 1: Tablets Were Prescribed by Doctor

Tablet	Dosage
Vitmin-A	5,000IU/day
Iron (Ferrous sulphate) Contains Appx.eq to 60 mg of ferrous iron	200 mg/day
Zinc (zinc gluconate)	25 mg/day
Vit-C (Ascorbic acid)	75 mg / day

Supplementation of Micronutrients: For combination of micronutrient supplementation 5 groups from stunted (s) and 5 from stunted & wasted (SW) categories were receive Fe+Vit-C, Zn+Fe, Vit-A+Zn, Vit-A+Fe and placebo groups received one capsule per day. The children in the placebo groups received gelatin tablet every during study period day. The grouping of the subjects for the supplementation is shown in Figure.1. The supplementation was carried out for a period of 4 months. Attendance record was maintained to ensure their regular participation.

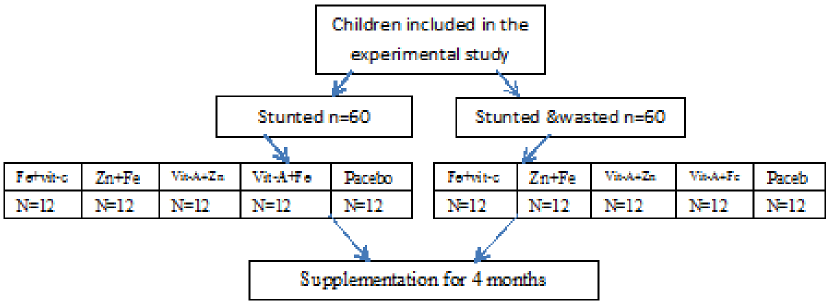

Figure 1

Evaluation of the Impact of Supplementation: The effect of supplementation was studied in all the 120 children in terms of anthropometric measurements (wt, ht, MUAC) and biochemical assessment was done through analysis of blood Hb, serum biochemistry which is serum zinc, serum retinol and serum iron. All the measurements were done initially and four months after experimentation.

RESULTS

The data on height (ht), weight (wt) and mid upper arm circumference (MUAC) of S, SW and placebo groups of children at baseline (B) and after (A) intervention is presented in table.2, 3&4 along with calculated 't' values for the change in ht, wt and MUAC. Irrespective of the different nutritional grades (S, SW and N) all the groups (n =8) belonging to different supplementation protocols and the respective placebo control groups (no= 2) showed a significant increase in ht, wt and MUAC over a period of four months.

Table 2: Mean Height (cm) Increments of Supplemented and Placebo Groups of S and SW Children

Supplement Protocols	Groups	Stunted (S)				Stunted and Wasted (SW)		
			Mean ±SD	Change	T-Value	Mean ±SD	Change	T-Value
Combination of two Nutrient Supplement (CNS)	Fe+V-C	B	121.88±5.92	0.81±0.37	7.47**	124.45±6.34	0.81±0.32	12.57**
		A	122.70±5.73			125.26±6.30		
	Zn+Fe	B	122.78±6.77	0.37±0.15	8.40**	120.76±7.28	0.47±0.20	8.02**
		A	123.15±6.73			121.24±7.16		
	V-A+Zn	B	125.11±4.21	1.26±0.25	17.31**	199.66±7.23	1.46±0.21	23.67*
		A	126.38±4.23			121.13±7.26		
	V-A+Fe	B	124.70±5.49	1.44±0.35	14.15**	121.09±6.36	1.42±0.25	19.53**
		A	126.15±5.32			122.51±6.30		
Placebo		B	124.30±7.23	0.35±0.13	9.00**	124.38±6.99	0.31±0.16	6.46**
		A	124.66±7.13			124.70±6.87		

* *Significant at p<0.01*Significant at p<0.05NS Not Significant

Table 3: Mean Weight (kg) Increments of Supplemented and Placebo Groups of S and SW Children

Supplement Protocols	Groups	S				SW		
			Mean ±SD	Change	T-Value	Mean ±SD	Change	T-Value
CNS	Fe+V-C	B	19.83±2.60	1.38±0.57	8.38**	18.37±2.52	1.49±0.42	12.09**
		A	21.21±2.79			19.86±2.23		
	Zn+Fe	B	20.58±2.73	0.37±0.22	5.74**	16.83±3.29	0.66±0.24	9.38**
		A	20.95±2.64			17.50±3.16		
	V-A+Zn	B	21.87±2.17	2.04±0.72	9.80**	17.08±2.33	1.45±0.45	15.07**
		A	23.91±1.95			19.04±2.40		
	V-A+Fe	B	21.66±2.40	2.04±0.58	12.14**	17.54±2.53	2.25±0.54	14.33**
		A	23.70±2.33			19.79±2.71		

Placebo	B	21.95±3.38	0.62±0.31	6.96**	18.62±2.86	0.37±0.31	4.18**
	A	22.58±3.28			19.00±2.75		

* *Significant at p<0.01*Significant at p<0.05NS Not Significant

Table 4: Mean Increments of MUAC (cm) of Supplemented and Placebo Groups of S and SW Children

Supplement Protocols	Groups		S			SW		
			Mean ±SD	Change	T-Value	Mean ±SD	Change	T-Value
CNS	Fe+V-C	B	16.25±1.07	0.06±0.06	3.54**	15.66±1.23	0.08±0.03	7.41**
		A	16.31±1.04			15.75±1.21		
	Zn+Fe	B	15.91±1.34	0.05±0.09	2.24**	15.00±1.36	0.13±0.12	3.75**
		A	15.97±1.30			15.13±1.26		
	V-A+Zn	B	16.66±0.88	0.14±0.07	6.18**	15.83±1.35	0.13±0.06	7.09**
		A	16.80±0.86			15.96±1.30		
	V-A+Fe	B	16.79±1.25	0.11±0.07	5.63**	15.75±1.48	0.12±0.06	6.96**
		A	16.90±1.19			15.87±1.45		
Placebo		B	16.16±1.48	0.03±0.06	1.77^{NS}	15.25±1.53	0.10±0.12	2.70**
		A	16.20±1.44			15.35±1.50		

* *Significant at p<0.01*Significant at p<0.05NS Not Significant

Effect of Supplementation on Micronutrient Status of School Going Children

The biochemical changes were studied in terms of serum levels of retinol, iron and zinc and of blood hemoglobin.

Changes Observed in the Vit-A Level of the Children

The mean baseline and followup levels of serum Vit-A of the participant children and calculated 't' values are presented in table 5.In the stunted category of children amongst the groups supplemented with a combination of two nutrients vit-A+Zn and Vit-A+Fe showed a mean retinol change of 3.60 and 2.53 µg/dl respectively which was significant at one per cent level. The other two groups Fe+vit-C and Zn+Fedid not show any significant increases in vit-A levels.

Table 5: Mean Increments of Serum vit-A Levels (µg/dl) of Supplemented and Placebo Groups of S and SW Children

Supplement Protocols	Groups		Stunted			Stunted and Wasted		
			Mean ±SD	Change	T-Value	Mean ±SD	Change	T-Value
CNS	Fe+V-C	B	29.76±8.16	0.31±1.30	0.84^{NS}	22.65±4.52	0.58±0.65	3.08**
		A	30.08±8.72			23.24±4.36		
	Zn+Fe	B	32.20±12.82	-0.08±0.69	0.41^{NS}	24.97±9.20	0.55±0.87	2.22*
		A	32.12±12.51			25.53±8.53		
	V-A+Zn	B	28.15±9.01	3.60±2.14	5.80**	23.49±4.14	4.04±0.89	15.69**
		A	31.75±7.25			27.53±3.98		
	V-A+Fe	B	33.40±11.39	2.53±1.73	5.05**	23.05±5.96	4.81±5.06	3.29**
		A	35.94±9.88			27.86±8.01		
Placebo		B	33.08±10.17	1.14±0.71	5.54**	23.24±3.97	1.73±2.60	2.30^{NS}
		A	34.22±10.48			24.97±3.95		

* *Significant at p<0.01*Significant at p<0.05NS Not Significant

In the SW group all the four supplemented groups were showed significant increments in serum vit-A levels. The stunted placebo group showed a significant (P<0.01) increase in the vit-A levels. However, the children in the SW placebo group did not show any statistically significant increments in vit-A levels.

Changes in Mean Serum Zinc

The mean serum zinc levels of children belonging to different nutritional grades who were administered with

different supplementation protocols from baseline to follow-up is presented in table no.6 along with the values of 't' test values conducted for the mean change in Zn levels.

In the stunted category of children the groups supplemented with a combination of two nutrients vit-A+Zn (2.95µg/dl) group recorded significant difference (P<0.01) and the Vit-A+Fe groups showed a significant difference at five per cent level. However, the change in Zn levels of Zn+Fe and Fe+Vit-C groups was not significant.

In the SW group the combination of two nutrient supplement groups only vit-A+Zn (4.47µg/dl) showed a significant (p<0.01) increase in serum Zn levels. The other groupsFe+vit-C (0.07), Zn+Fe (-0.84) and vit-A+Fe (5.03) did not show significant increments in Zn level (µg/dl). The children who received placebo in S, SW groups did not show significant increments in Zn levels (0.30, 1.81 and -0.15 µg/dl respectively.

Table 6: Mean Increments of Serum Zinc Levels (µg/dl) of Supplemented and Placebo Groups of S and SW Children

Supplement Protocols	Groups		Stunted (S)			Stunted and Wasted (SW)		
			Mean ±SD	Change	T-Value	Mean ±SD	Change	T-Value
CNS	Fe+V-C	B	66.87±18.06	3.64±9.92	1.27^{NS}	54.34±7.80	0.07±0.91	0.28^{NS}
		A	70.51±16.34			54.26±7.13		
	Zn+Fe	B	65.81±18.45	-1.48±2.26	1.42^{NS}	57.30±12.63	-0.84±1.63	1.78^{NS}
		A	64.33±19.27			56.46±12.30		
	V-A+Zn	B	66.49±15.69	2.95±2.01	5.07**	52.90±7.18	4.47±1.01	15.19**
		A	69.44±14.49			57.37±7.06		
	V-A+Fe	B	67.22±19.67	1.30±1.53	2.93*	55.80±8.05	5.03±12.05	1.44^{NS}
		A	68.52±18.97			60.83±14.21		
Placebo		B	74.63±21.13	0.30±1.46	0.70^{NS}	56.82±12.61	1.81±4.98	1.26^{NS}
		A	74.93±20.19			58.64±11.23		

* *Significant at p<0.01*Significant at p<0.05NS Not Significant

Changes Observed in the Iron Levels of Children

The mean serum iron levels along with calculated 't' values are presented in table 7.In the stunted category of children the combination of two nutrients supplement groups Fe+Vit-C and vit-A+Fe recorded an increment of 2.17 and 1.92 µg/dl respectively which was significant at one per cent level. The increments of Zn+Fe (-0.65 mcg/dl) and vit-A+Zn (0.16 µg/dl) groups were not statistically significant.

In the stunted & wasted group the combination of two nutrient supplement groups Fe+Vit-C and Vit-A+Zn recorded significant (P<0.01) increment in iron levels of 2.95 and 0.90 mcg/dl respectively. The Zn+Fe (-0.25µg/dl) and vit-A+Fe (9.55 µg/dl) groups were showed no significant improvements.

Table 7: Mean Increments of Serum iron Levels (mcg/dl) of Supplemented and Placebo Groups of S and SW Children

Supplement Protocols	Groups		Stunted (S)			Stunted and Wasted (SW)		
			Mean ±SD	Change	T-Value	Mean ±SD	Change	T-Value
CNS	Fe+V-C	B	56.51±23.49	2.17±1.88	3.98**	46.14±4.56	2.95±1.58	6.45**
		A	58.69±22.29			49.09±4.38		
	Zn+Fe	B	62.15±30.33	-0.65±1.57	1.42^{NS}	56.05±25.11	0.25±1.54	0.58^{NS}
		A	61.50±29.78			55.80±25.19		
	V-A+Zn	B	60.93±21.55	0.16±1.43	0.40^{NS}	45.92±2.68	0.90±0.75	4.18**
		A	61.10±20.61			46.83±2.99		
	V-A+Fe	B	73.96±30.81	1.92±1.34	4.96**	45.32±4.36	9.55±24.9 0	1.30^{NS}
		A	75.89±29.67			54.88±21.71		

Placebo	B	76.95±29.08	0.29±1.04	0.97^{NS}	45.75±3.54	1.25±3.11	1.38^{NS}
	A	76.66±28.75			47.01±2.93		

* *Significant at p<0.01*Significant at p<0.05NS Not Significant

Mean Changes in Blood Hemoglobin Levels

The mean initial and final blood Hb levels of the children and calculated‘t’ values are presented in table 8.In the stunted category of children the Fe+vit-c and vit-A+Fe groups showed an increase of 0.67 and 0.55 g/dl respectively in Hb which is significant at 1percent level whereas the grousZn+Fe and Vit-A+Zn recorded very slight differences which was not significant.

Table 8: Mean Increments of Hb Levels (g/dl) of Supplemented and Placebo Groups of S and SW Children

Supplement Protocols	Groups	Stunted (S)				Stunted and Wasted (SW)		
			Mean ±SD	Change	T-Value	Mean ±SD	Change	T-Value
CNS	Fe+V-C	B	10.50±1.05	0.67±0.40	5.77**	9.55±0.84	0.97±0.40	8.43**
		A	11.17±0.73			10.53±0.62		
	Zn+Fe	B	10.75±1.40	0.08±0.44	0.64^{NS}	10.14±1.33	0.04±0.38	0.37^{NS}
		A	10.84±1.18			10.10±1.19		
	V-A+Zn	B	10.72±0.73	0.01±0.22	0.25^{NS}	9.70±0.50	0.25±0.20	4.28**
		A	10.70±0.84			9.95±0.41		
	V-A+Fe	B	11.02±1.17	0.55±0.41	4.64**	9.57±0.89	1.10±0.62	6.16**
		A	11.58±0.83			10.68±0.98		
Unsupplemented Controls	Placebo	B	11.12±1.04	0.06±0.21	1.07^{NS}	9.94±0.80	0.11±0.13	1.49^{NS}
		A	11.19±0.99			10.00±0.72		
	Normal	B	13.05±0.84	0.02±0.33	0.37^{NS}	13.05±0.84	0.02±0.33	0.37^{NS}
		A	13.08±0.78			13.08±0.78		

* *Significant at p<0.01 *Significant at p<0.05NS Not Significant

DISCUSSIONS

Attainment of growth is an important and significant function of childhood years. The role of micronutrient malnutrition in the attainment of growth of school age is of particular importance in view of its prognostic ability of predicting adolescent growth and development.

The supplemented and placebo groups showed significant increments for the select anthropometric measurements during the experimental period of four months. As per the standards of reference both boys and girls in ages 8 to 10 yrs should show increments in height between 2.5 to 3.0 cm over a period of 6 months. It is an established fact that weight is a sensitive indicator of nutritional status and the effect of improved nutrition situation can easily be demonstrated through gain in weight. However, low heightt is an indicator of past chronic malnutrition and longer periods of interventions are required to demonstrate increments in ht to reach levels that are on par with those of the healthy groups.

The increments in height and weight of S and SW children reveal that all supplement protocols groups showed significantly better performance when compared to respective placebo and Zn+Fe groups. Micronutrient supplementation improves the nutritional status of the school children (Sireesha and Kusuma, 2014).

Study on nutritional status of primary school children from South Africa, found that 40 percent of children has sub-clinical VAD (Stuijvenberg et al., 1999).

The present group of school going children is found to be suffering from the select micronutrient deficiencies.In the S children vit-A+Zn resulted in highest increments in serum vit-A status. This was followed by vit-A+Fe supplement.

Several treatments in the SW however showed similar significant responses which were at three levels. Here also vit-A+Fe and vit-A+Zn showed highest increments in serum vit-A levels.

Higher increment was found in SW group than S group with vit-A+Fe and vit-A+Zn treatment. In the S children vit-A+Zn showed highest serum vit-A levels. Zn supplementation of children with VAD has been reported to result in a significant increase in plasma vit-A (Shingwekar et al., 1979).

Several studies showed a positive effect of Zn supplementation on vit-A nutritional status (Shingwekar, et al., 1979; and Morrison, et al., 1978), suggesting a metabolic interaction between the two nutrients.

The supplementation with Zn + Fe significantly increased plasma retinol but not RBP or transthyretin. Children deficient in Zn, Fe and vit-A as indicated by nutrient plasma concentration in the beginning of the study showed significantly greater increase in retinol than did children with adequate nutrient status (Munoz et al., 2000). The findings of the present study are in accordance with those reported by Munoz et al., suggesting that the deprived are benefited by supplementation.

With regard to increments in serum Zn the Fe+vit-C, vit-A+Zn, &vit-A+Fe in the S group and vit-A+Fe,vit-A+Zn in SW showed better performance than the respective placebo groups.

After supplementation maximum and significant increment in serum Zn levels was registered for vit-A+Znandvit-A+Fe groups of S group children; and that of SW group who received vit-A+Zn. Christian et al., (2001) reported that VAD is associated with lower serum Zn level.

Studies of the effect of Zn supplementation on serum or plasma Zn concentration yielded different results. A prolonged supplementation for 6 months period, led to a significant improvement in Zn status among Thai children (Udomkesmalee et al., 1992); the mean Zn levels increased from 13.2 to 19.0 μmol/ L after daily supplementation with 25 mg Zn. In the present context 4 months daily supplementation of 25 mg has registered similar mean increments of 5.03 0 μg/dl to 3.640 μg/ dl. In the present study S group showed a significant improvement in Zn status; the mean Zn levels increased from 76.17 to 77.66 mcg/dl after daily supplementation with 25 mg Zn. The SW group however did not show significant increment probably because the dose of Zn was not sufficient to meet the increased needs due to gross deficiency.

High intake of non-heme Fe inhibits the absorption of Zn (Sandstorm et al., 1985) and conversely, a high ratio of dietary Zn to Fe can inhibit Fe absorption. Interaction between Fe and Zn occurs during the absorption phase. When given as a supplement, Fe inhibits Zn absorption if the ratio of Fe to Zn is greater than 2 to 1. Decreased serum Zn concentrations have been reported after Fe supplementation with doses>60 mg/d (Hambidge et al., 1983; 1987 and Brabin et al., 1999). In the present study 60 mg of Fe and 25 mg of Zn which is in the ratio of 2.5 which probably might have been the reason for very low increments in serum Zn observed for Zn+Fe combination both in the S and SW. Which further points out the fact that in deficient children such imbalances may precipitate the existing biochemical deficiencies and lead to the severe form of clinical deficiency.

In the present study the supplementation of S group of children with Fe+vit-C, vit-A+Fe showed a significant increase in serum Fe concentrations. In the SW group the treatments which showed significant increase in Fe levels were the supplementation of Fe+vit-C, vit-A+Zn. This effect was much more evident in children who were initially deficient in Zn, Fe and vit-A. The serum Fe increments recorded by the different treatment groups were similar.

Dijkhuizen et al., (2001) reported that children who were given 10 mg of Fe per day for a period of 10 mo significantly helped in reducing the prevalence of anemia and in increasing the Hb and serum Fe levels in children. In the present study however, a higher dose of 60 mg/ child/ day is given for a short period of 4 months, resulted in better serum Fe levels and also improved Hb status.

A study of reducing anemia in adolescent school girls in Peru tested both daily and intermittent iron supplementation (60mg of ferrous sulphate) over a 17 week period. It was found that while both supplementation schedules resulted in improved iron status, daily supplementation resulted in the greatest increase in hemoglobin concentration and significantly reduced the prevalence of anemia (Zavaleta et al., 2000).

In the present group of children the supplementation protocols did not show an appreciable increase in the serum iron levels; however, the Hb increments were significant for a majority of supplement groups. This may be due to the fact that the children were in the severely iron deficient state suffering with anemia what ever iron is provided might have been channelized into the functional forms of iron.

A randomized, double-blind, controlled study of the effects of dietary supplements on anemia in teenagers was conducted in urban Bangladesh. Participants were provided weekly supplements for 12 weeks. Compared with the placebo, the iron, folic acid and vit-A supplement reduced anemia by 92 percent, iron deficiency by 90 percent and VAD by 76 percent. Those with the lowest baseline hemoglobin had the greatest increase in hemoglobin (Ahmed et al., 2001).

Several studies have reported that zinc supplementation did not change in Hb (Christian, et al., 2001; Osendorp, et al., 2000; Shankar et al., 2000). It is expected that in persons with low Hb, iron is absorbed well and iron indices will improve fast (De-oliviera and Scheid, 1996). The low mean Hb of the present group of children might have shown a favorable response for all supplements.

Bui Dai Thu et al., (1999) studied the efficacy of weekly and daily supplementation in reducing anemia prevalence and in improving the Zn, vit-A and growth status of 6-24-mo-old Vietnamese children.

Anemia and iron deficiency were common in the present study child population studied. The S children in the treatment group who received the Fe+vit-C, vit-A+Fefor 4 mo showed significant improvements in Hb levels of the children than other supplemented and placebo groups. In the SW group of children in the treatment groupsvit-A+Fe, Fe+vit-C, vit-A+Zn showed significant improvements in HB levels than other treatment groups. About very small percent of children has showed increment in S group. It is evident that a higher number of treatment groups of SW children had responded by increased Hb when compared to S group of children. The functional consequences of anemia in school-age children point to the urgency of addressing this public health problem.

Iron deficiency anemia is frequently the result of low dietary iron absorption due to low intakes of meat and high intakes of inhibitors, such as phytate and polyphenols. These same dietary factors decrease bioavailability of zinc (Lonnerdal, 2000). Although the data do not suggest that zinc deficiency plays a role in anemia, deficiencies of iron and zinc often coexist, and supplements containing both iron and zinc could be of value in vulnerable populations. However, several studies have suggested concurrent zinc supplementation may reduce the efficacy of iron possibly by impairing iron absorption. However, high intake of nonheme iron inhibits the absorption of zinc (Valberg et al., 1984; Sandstrom et al., 1985), and conversely, a high ratio of dietary zinc to iron can inhibit iron absorption (Crofton et al., 1989 and Hulten et al., 1991). These interactions have been reported when the micronutrients were given in a water solution in adults, but not

when given in infant formula or meals (Davidsson et al., 1996; Haschke et al., 1986 and Fairweather–Tait et al., 1995). The mechanism of this interaction is not clear, but may involve competion for absorption in the small intestine. The DMT1 transports both iron and zinc ions (Gunshin et al., 1997).

In a randomized controlled supplementation trial in Vietnam, infants received daily either 10 mg iron, 10 mg zinc, 10mg iron plus 10 mg zinc, or a placebo. The combined iron-zinc supplementation was as effective as iron supplements to control iron deficiency and anemia (Berger et al., 2006). While the combination of Zn+Fe did not show a significant improvement in Fe and Hb. This might be due to the high dose of Fe and Zn which might have competed with absorption. Similar findings were reported in studies on Indonesian infants (Dijkhuizen et al., 2001; Lind et al., 2003) with the same doses and duration of zinc and iron supplementation used in the Vietnam study (Berger et al., 2006), the combined iron-zinc supplementation was less effective on improvement of iron status. These data suggest that concurrent zinc supplementation reduced the efficacy of the iron.

Mwanri et al., (2000)suggested that vitamin-A and iron supplementation have a role in the prevention of IDA and growth retardation. In the present study vit-A+Fe supplementation showed significant increment of serum Fe and Hb levels.

In a randomized double-blind control trial with 830 primary school children from Tanzania, the odds of stunting were significantly reduced by provision of a micronutrient – fortified beverage (Ash et al.,1999).

A recent study in 60 non-formal schools in Mali found that supplementation with 65 mg iron and 250µg folic acid weekly for 10 weeks improved hemoglobin concentration by 3.9 g/L in comparison with a placebo group. All children were given deworming treatment and vitamin-A supplements prior to the trial (Berger et al., 1997).

CONCLUSIONS

The present investigation reiterate the fact that there are intra-and inter-actions existing among the macro and micronutrients that influence the efficacy of single or multiple micronutrient supplementation. Interventions that work need to be applied together at the same time, in the places where they can do the most good. Further, nutritional safety net for those who connot care for and feed themselves is imperative particularly in the low income groups.

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